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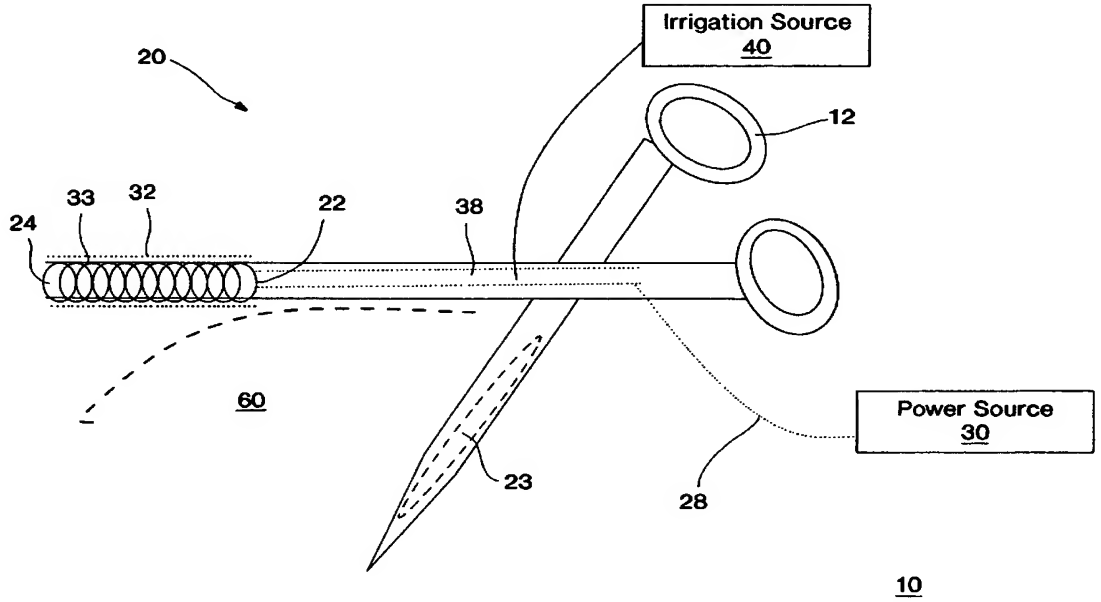
(54) Title: VARIABLE LENGTH ELECTRODES FOR DELIVERY OF IRRIGATED ABLATION



(57) Abstract: A device for ablating tissue is provided. The device comprises a conductive element with a channel for irrigating fluid formed therein, which is in contact with a non-conductive microporous interface. All or a portion of the interface may be removable. When the interface is removed, a portion of the conductive element is exposed for use in ablating tissue. Methods of using the device and for removing the interface are also provided.

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VARIABLE LENGTH ELECTRODES FOR DELIVERY OF IRRIGATED ABLATION

FIELD OF THE INVENTION

This invention relates to ablation devices that are used to create lesions in tissue. More particularly, this invention relates to conductive elements for use in such devices which vary in length and which incorporate improved methods of irrigation delivery.

BACKGROUND OF THE INVENTION

The action of the heart is known to depend on electrical signals within the heart tissue. Occasionally, these electrical signals do not function properly. The maze procedure is a surgical operation for patients with chronic atrial fibrillation that is resistant to medical treatment. In this procedure, incisions are created in the right and left atria to produce an orderly passage of the electrical impulse from the SA node to the atrioventricular node. Blind passageways are also created to suppress reentry cycles. Currently, the lesions may still be created using a traditional cut and sew technique. The scar tissue resulting from the procedure results in a non-conductive lesion.

Ablation of cardiac conduction pathways in the region of tissue where the signals are malfunctioning is now being used to replace the surgical incisions. Ablation is also used therapeutically with other organ tissue, such as the liver, prostate and uterus. Ablation of organic tissue is also used in several surgical procedures, for both diagnosis and therapy.

In one type of procedure, one or more electrodes at the tip of an electrophysiology ablation device allow the physician to measure electrical signals along the surface of the heart (mapping). When necessary, in another type of procedure, the physician can also ablate certain tissues using, typically, radio frequency (RF) energy conducted to one or more ablation electrodes. During tissue ablation, energy is used to create lesions in the tissue for different purposes. High levels of energy are used to cut and remove tissue (electrosurgery). Lower levels of energy are used to cause cell damage but leave the structure intact so that electrical pathways are blocked within the tissue.

A variety of devices, such as catheters, are used to ablate tissue. Typically, such devices include a conductive tip, which serves as one electrode in an electrical circuit. The electrical circuit is completed via a grounding electrode that may also be on the device or may be coupled to the patient. By controlling the level of energy transmitted to the electrode, the surgeon is able to control the amount of heat generated for the purposes described above.

Irrigation of the ablation site cools the electrode. Irrigated ablation is also known to create deeper lesions that are more likely to be transmural. Transmurality is achieved when the full thickness of the target tissue is ablated.

During ablation, irrigation of the ablation site helps to cool the ablation electrodes, thereby reducing overheating in the vicinity of the electrodes. Undesirable consequences of overheating include the excessive coagulation of blood and the unintended destruction of healthy tissue adjacent the ablation site. The efficient cooling of the linear ablation electrode permits longer lesions to be created by permitting higher ablation energy without resulting in excessive electrode heating.

Typically, delivery of irrigation to the site is accomplished using a separate irrigation source which may pump into the ablation device or which may pump directly to the target tissue site. This requires a separate device that may not deliver irrigation as site-specifically as desired.

Furthermore, there is relatively high hydraulic impedance to saline flow at the distal end (towards ablation site) of a typical ablation device. In comparison, the hydraulic impedance to flow is lower at the proximal end (towards user) of the device. This sometimes results in more irrigation fluid being distributed at the proximal end than at the distal end.

Additionally, there may also be difficulties with electrical impedance to saline flow in a typical ablation device. This may be particularly true in a hemostat-type ablation device. In such a device, the target tissue is positioned between the two jaws of the hemostat, both of which carry ablation electrodes. If the tissue is shorter than the length of the hemostat jaws, a saline bridge may form between the hemostat jaws due to the surface tension of the fluid. This saline bridge is a low electrical impedance pathway. Electrical flow may, therefore, occur preferentially towards the bridge and yield unreliable ablation.

Irrigation fluid may also not be evenly distributed along a single electrode because of the impedance factors described above. Uneven distribution of fluid may result in an uneven lesion. In some cases, the tissue may not receive any irrigation in some areas. The electrode may contact the surface of the target tissue in these unirrigated areas, causing sticking or even charring.

Additionally, longer electrodes are sometimes desired to create longer lesions. These electrodes have a larger pressure drop along their length. This results in greater fluid flow from the proximal end than the distal end and thus irrigation is unevenly distributed which may result in sticking of the ablated tissue to the electrode. Currently an electrode of a given length is needed to create a lesion of a given length. If a lesion of a different length is desired, a new electrode must be used.

It would be desirable therefore to provide a means to control and vary irrigation.

It would further be desirable to facilitate control of lesion length.

It would further be desirable to provide a means for evenly irrigating an ablation electrode and concomitant target tissue site.

It would further be desirable to provide a means for evenly irrigating ablation electrodes of variable length.

It would further be desirable to provide a device in which irrigation capabilities and ablation capabilities are integrated.

SUMMARY OF THE INVENTION

One aspect of the present invention provides a device for ablating organic tissue. The device includes a conductive element, a fluid component in communication with the conductive element and a non-conductive interface positioned adjacent the tissue to allow the fluid to pass through the interface and contact the tissue. The conductive element may be, for example, a metallic coil with a lumen, a spring with a lumen or a wire. The diameter of the conductive element may be greater than the diameter of the interface. The conductive element and the interface may be the same. The interface may be micro-porous. The interface may also be of a variable length and a portion of the interface may be removable. The interface may be perforated, may comprise openings that are slidably or rotatably opened. The interface may be non-conductive or conductive. The interface

may lie between the conductive element and the tissue surface. The interface may encircle the conductive element and the fluid component. The interface may be a rigid structure, a fluid saturated gel, or a micro-porous section of the fluid component. The interface and the fluid component may be the same. The fluid component may be a non-porous coating. The device may also include means for flowing the fluid component through the interface, such as an infusion pump.

Another aspect of the invention provides a device for creating ablations of variable length, comprising a conductive element having a channel formed therein, the channel operatively adapted to receive irrigating fluid; and a removable non-conductive interface in communication with the conductive element. The device may include a support element in communication with the conductive element. The support element may be a slotted tube. The conductive element may be a slotted tube.

Another aspect of the invention provides a device for creating ablations of variable length, comprising a non-porous tube operatively adapted to receive irrigating fluid therein, a conductive element in communication with the tube and a removable non-conductive interface in communication with the conductive element. The non-conductive interface may be a portion of the non-porous tube. The non-conductive interface may be micro-porous. The non-conductive interface may be rigid.

Another aspect of the present invention provides a device for creating ablations of variable length, comprising a non-porous tube operatively adapted to receive a hydrogel, a conductive element in communication with the tube and a removable non-conductive interface in communication with the conductive element. The non-porous tube may be slotted.

Another aspect of the present invention provides a method of ablating organic tissue. The method includes providing a conductive element having a channel formed therein, the channel operatively adapted to receive irrigating fluid; and a removable non-conductive interface in communication with the conductive element. The method also includes removing a portion of the interface to expose a portion of the conductive element and ablating the tissue with the exposed portion of the conductive element. The interface may be perforated. The interface may be disposable. The interface may be reusable. The interface may also be a removable tip.

The foregoing, and other, features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims in equivalence thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a system for ablating tissue in accordance with the present invention;

FIG. 2 is a longitudinal schematic view of a variable length ablation electrode in accordance with the present invention;

FIG. 3 is a longitudinal schematic view of a second embodiment of a variable length ablation electrode in accordance with the present invention;

FIG. 4 is a schematic view of a cross-section of a third embodiment of a variable length ablation electrode in accordance with the present invention;

FIG. 5 is a longitudinal schematic view of a fourth embodiment of a variable length ablation electrode in accordance with the present invention;

FIG. 6 is a longitudinal schematic view of a fifth embodiment of a variable length ablation electrode in accordance with the present invention;

FIG. 7 is a schematic view of a cross-section of one embodiment of an ablation electrode in accordance with the present invention;

FIG. 8 is a schematic view of a cross-section of another embodiment of an ablation electrode in accordance with the present invention;

FIG. 9 is a schematic view of a cross-section of another embodiment of an ablation electrode in accordance with the present invention;

FIG. 10 is a schematic view of a cross-section of another embodiment of an ablation electrode in accordance with the present invention;

FIG. 11 is a schematic view of a cross-section of another embodiment of an ablation electrode in accordance with the present invention; and

FIG. 12 is a schematic view of a cross-section of another embodiment of an ablation electrode in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

FIG. 1 shows a schematic view of one embodiment of system **10** for ablating tissue in accordance with the present invention. Typically the tissue to be ablated will be located within the body cavity, such as the endocardial or epicardial tissue of the heart. Other body organ tissue, such as the liver, can also be ablated using the present invention. System **10** may include an ablation device **20** that comprises at least one conductive element **22**, such as an electrode, and a connection **28** to a power source **30**. System **10** also may include a conduit **38** to an irrigation source **40** that provides irrigation fluid to the ablation site. System **10** may also include an insulating material **32** that may insulate conductive element **22**. Insulating material **32** may also direct delivery of energy and/or irrigation along conductive element **22.** System **10** may also include a support member **33** that may provide structural integrity to conductive element **22**. System **10** may also include an indifferent electrode **23** which may serve as the return plate for energy transmitted through electrode **22**. Electrode **23** may also be covered by insulating material and supported by a support member.

Ablation device **20** may be any suitable ablation tool such as, for example, a catheter, an electrocautery device, an electrosurgical device, a suction-assisted ablation tool, an ablation pod, an ablation paddle, an ablation hemostat or an ablation wire. Ablation device **20** and its components are preferably made of a biocompatible material such as stainless steel, biocompatible epoxy or biocompatible plastic. Preferably, a biocompatible material prompts little allergenic response from the patient's body and is resistant to corrosion from being placed within the patient's body. Furthermore, the biocompatible material preferably does not cause any additional stress to the patient's body, for example, it does not scrape detrimentally against any elements within the surgical cavity.

Preferably, ablation device **20** may be permanently or removably attached to a maneuvering apparatus for manipulating device **20** onto a tissue surface. For example, ablation device **20** may be attached to hemostat handles **12** such as shown in **FIG. 1**. Ablation device **20** may also be located on one or more of the hemostat jaws **32**. Ablation

device **20** may also be used in conjunction with a traditional catheter, for example, in a closed heart ablation procedure. Ablation device **20** may also be maneuvered with a leash or pull-wire assembly. Ablation device may also be positioned on a pen-like maneuvering apparatus such as the Cardioblate pen available from Medtronic, Inc. Alternatively any appropriate flexible or rigid handle could be used as a maneuvering apparatus. Alternatively, any appropriate endoscopic or thoroscopic-maneuvering apparatus may also be used with device **20**.

Device **20** also preferably includes a connection **28** suitable for conducting energy to device **20**, particularly to conductive element **22** from a power source.

The conductive element **22** of ablation device **20** is preferably an electrode. This electrode **22** may be positioned in any suitable place on device **20**. Preferably electrode **22** is placed near an end of the device **20**, away from the user, to be more easily manipulated against the tissue **60** to be ablated.

System **10** may also include an indifferent electrode **23** which may serve as the return plate for energy transmitted through electrode **22**.

Electrode **23** may be placed elsewhere on the patient's body than the ablation site. For example, electrode **23** may be placed on the patient's back or thigh. Electrode **23** may also serve as a second ablation electrode in a bipolar arrangement. The two electrodes **22**, **23** may be arranged on the jaws of a hemostat-like tool such as shown in **FIG. 1**. Electrodes **22**, **23** may be arranged in other orientations to each other, such as, for example, parallel to each other on a surface.

As ablation occurs, it is sometimes desirable to irrigate the ablation site with irrigation fluid, which may be, for example, any suitable fluid such as saline or another conductive fluid. The irrigating fluid may cool the electrode **22** of ablation device **20**. Irrigated ablation is also known to create deeper lesions that are more likely to be transmural. Transmurality is achieved when the full thickness of the target tissue is ablated. Furthermore, continuous fluid flow may keep the ablation device surface temperature below the threshold for blood coagulation, which may clog the device. Use of irrigating fluid may therefore reduce the need to remove a clogged ablation device for cleaning or replacement. The presence of an ionic fluid layer between electrode **22** and the tissue to be ablated may also ensure that an ionic fluid layer conforming to the tissue

contours is created. In one preferred embodiment, saline solution is used. Alternatively, other energy-conducting liquids, such as Ringer's solution, ionic contrast, or even blood, may be used. Diagnostic or therapeutic agents, such as lidocaine, CA^{++} blockers, ionic contrast, or gene therapy agents may also be delivered before, with or after the delivery of the irrigating fluid. Irrigation source **40** may be any suitable source of irrigation fluid such as, for example, a standard irrigation pump (not shown). This pump may also be connected to power source **30** or may have its own source of power. Preferably, device **20** also includes a conduit **38** for delivering irrigation to the ablation site from irrigation source **40**.

FIG. 2 shows a schematic representation of one embodiment of a variable length electrode in accordance with the present invention. Electrode **222** may be covered with an insulating material **232**. Prior to ablation, insulating material **232** may be removed, for example, by rolling back towards a proximal end of electrode **222**. As insulating material **232** is rolled back, ablating surface **242** of electrode **222** may be revealed. The ablating surface may be applied against a surface of tissue **260**. The length of ablating surface **242** may vary, depending on the amount of insulating material **232** that is uncovered. Insulating material **232** is preferably a material that insulates the unexposed area of the electrode **222**. Such an insulating material may be, for example, silicone or polyurethane. The exposed ablation surface **242** may be conductive and irrigated. However, the section of electrode **222** covered by insulating material **232** may be non-conductive. Furthermore, the section of electrode **222** covered by insulating material **232** may be formed of a material that does not allow irrigating fluid to flow through. Since the irrigating fluid does not flow through the insulated end, a saline bridge as described above may not form. Additionally, the insulating material may direct all energy so that it is delivered to the exposed portion **242** of electrode **222**. Additionally, the insulating material may direct all irrigating fluid so that it is delivered to the exposed portion **242** of electrode **222**. The irrigation fluid may flow within the insulating material **232** but may not flow through the material **232**. Therefore, the unexposed, insulated portion of tool **20** may not be irrigated. The irrigating fluid may thereby delivered only to the desired, exposed portion **242** of electrode **222**.

Insulating material **232** may then be returned to its original state to cover exposed surface **242**. The same electrode **222** may then be used to ablate a shorter surface. Alternatively, insulating material may be a tip, which may be removed completely. A new insulating material may then be placed over electrode. These tips of insulating material **232** may be of variable length.

FIG. 3 shows a schematic longitudinal representation of another embodiment of the variable length electrode of the present invention. In this embodiment, insulating material **332** is perforated. In use, a user may remove insulating material **332** from segment **A**, thereby exposing ablation surface **342** as shown. If the user desires, a longer ablation surface in order to create a longer lesion, he may remove additional insulating material **332** from segment **B**. This results in longer ablation surface **343** as shown. Preferably insulating material that is removed may be disposable.

FIG. 4 shows a cross-section view of another embodiment of the variable length electrode of the present invention. In this embodiment, electrode **422** may be covered by insulating material **432** and a rotating portion of insulating material **452**. Portion **432** of the insulating material may cover most of the electrode **422**. Electrode **422** may remain covered by portion **432** of the insulating material along the length of the electrode. Meanwhile, portion **452** of the insulating material may be removable or movable. Preferably, portion **452** may be rotatably removable or movable. In use, portion **452** of the insulating material may be moved to uncover ablating surface **442**. For example, portion **452** of the insulating material may be moved in the direction indicated by the arrow to remove the cover. Portion **452** may be moved to expose ablating surface **442** of electrode **422** along the entire length of electrode **422**. Alternatively, portion **452** of insulating material may be moved to uncover ablation surface **442** only along a given portion of electrode **422**. Ablating surface **442** may be used to ablate a surface of tissue **460**.

FIG. 5 shows a longitudinal schematic view of the variable length electrode of the present invention. In use, the insulating material **532** shown in **FIG. 5** may be formed as a series of panels that cover electrode **522**. For example, three panels, **A**, **B**, and **C** are shown in **FIG. 5**. Panel **A** of insulating material **532** may be moved to fit over panel **B** of insulating material **532**. Panel **A** may be moved, for example, in the direction indicated by the arrows. This may expose ablation surface **542** which may have originally been

covered by panel **A**. If the user desires a longer length electrode to create, for example, a longer lesion, the user may slide panel **B** over panel **C** and panel **A** over panel **B** to expose an even longer ablation surface **543**. Ablating surface **542, 543** may be used to ablate a surface of tissue **560**.

In the embodiments shown in **FIGS. 1-5,** the conductive element may preferably be a coil or spring. Alternatively, the conductive element may be metallic rod with a lumen machined into its axis, a wire braid, a wire mesh or another suitable type of electrode.

FIG. 6 shows a longitudinal schematic view of a conductive element **22** in accordance with the present invention. Preferably, the coil or spring may be made of a conductive material such as, for example, metal. This coil may have a lumen **24**. Irrigating fluid may be flowed into the lumen **24** of coil **22**. For example, irrigating fluid may be pumped from irrigation source **40**. As the fluid is pumped from irrigation source **40**, the fluid may weep evenly along the length of the coil, thus delivering fluid to the ablation site. A support member **33** may also be incorporated into or adjacent conductive element **22**. Preferably support member **33** provides conductive element **22** with additional structural rigidity. The support member **33** may be, for example, a slotted metal tube. The support member may also be made from materials, such as, for example, Nitinol or other superelastic materials, which may allow support and some malleability.

Slotted tube **33** may be formed of a slightly smaller diameter than coil **22**. In this case, a portion of coil **22** may protrude through the slot of tube **33** as shown at **630**. This protruding of coil **22** may occur along the length of electrode **22**. Alternatively, this protruding may occur at a given area of electrode **22**. This protrusion may help coil **22** conform to the surface of tissue **660** to be ablated.

Preferably, the pitch or tightness of the coil of conductive element **22** may determine the current density of the conductive element **22**. Increasing the pitch of the coil (i.e. winding the coil less tightly) may decrease the current density of the conductive element. Decreasing the pitch may increase the current density of conductive element **22.**

Preferably, the pitch or tightness of the coil of conductive element **22** may determine the flow rate of the irrigation fluid through the conductive element **22**. Increasing the pitch of the coil (i.e. winding the coil less tightly) may increase the flow

rate of irrigation fluid through conductive element **22**. Decreasing the pitch may decrease the flow rate of irrigation fluid through conductive element **22**.

As seen in the embodiment of **FIG. 6**, the coil **22** may be a double coaxial, reverse-wound spring. This embodiment, for example, provides an increased resistance to fluid flow and nets a more even distribution along the length of the coil. Therefore, by varying the pitch of a conductive coil **22**, characteristics of the lesion created along the length of the electrode may also be varied. Thus if a surgeon were to desire a shallower lesion at section **F** than at section **G**, he may use a variable pitch electrode as shown in **FIG. 6**. The decreased pitch at section ***f*** of electrode **22** may result in a lower rate of irrigation flow. This may create a shallower lesion at section **F** of the tissue. The increased pitch at section ***g*** of electrode **22** may result in a higher rate of irrigation flow. This may create a deeper lesion at section **G** of the tissue.

FIG. 7 shows a schematic view of a cross-section of a variable length electrode in accordance with the present invention. Conductive element **622** may be for example a double wound coil or spring as described above. Irrigating fluid may be flowed through the lumen **724** of electrode **722**. Support element **733** may be for example a slotted tube. Such a slotted tube **733** may be any suitable material that may provide additional structural integrity to conductive element **722**. The slotted tube **733** has an opening or slot **734**. Preferably this opening **734** may run the length of an entire conductive element **722**. This opening **734** may also run the length of an exposed section of a conductive element **722** which may be exposed in a manner as described in the above embodiments. This opening **734** may preferably face a surface of the tissue **760** to be ablated. As shown in **FIG. 7**, insulating material **732** may cover a portion of conductive element **760** rather than covering the entire conductive element **722**. Insulating material **732** may be for example a microporous non-conductive component. Such a microporous non-conductive component may be manufactured from a material such as silicone, PTFE, Dacron fabric or solvent-precipitated polyurethane. Preferably, the pores in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **724** of conductive element **722** in the manner indicated by the arrows.

FIG. 8 shows a schematic view of a cross-section of a second embodiment of a variable length electrode in accordance with the present invention. Conductive element **822** may be for example a double wound coil or spring as described above. Irrigating fluid may be flowed through the lumen **824** of electrode **822**. Support element **833** may be for example a slotted tube. Such a slotted tube **833** may be any suitable material that may provide additional structural integrity to conductive element **822**. The slotted tube **833** has an opening or slot **834**. Preferably this opening **834** may run the length of an entire conductive element **822**. This opening **834** may also run the length of an exposed section of a conductive element **822** which has been exposed in a manner as described in the above embodiments. This opening **834** may preferably face a surface of the tissue **860** to be ablated. As shown in **FIG. 8**, insulating material **832** may cover all of conductive element **822**. Insulating material **832** may also cover slotted tube **833**. Insulating material **832** may be for example a microporous non-conductive component. Such a microporous non-conductive component may be manufactured from a material such as silicone, PTFE, Dacron fabric or solvent-precipitated polyurethane. Preferably, the pores in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **824** of conductive element **822** in the manner indicated by the arrows.

FIG. 9 shows a schematic view of a cross-section of a third embodiment of a variable length electrode in accordance with the present invention. Conductive element **922** may be a slotted tube that also serves as a support element. Irrigating fluid may be flowed through the lumen **924** of electrode **922**. The slotted tube **922** has an opening or slot **934**. Preferably this opening **934** may run the length of an entire conductive element **922**. This opening **934** may also run the length of an exposed section of a conductive element **922** which may be exposed in a manner as described in the above embodiments. This opening **934** may preferably face a surface of the tissue **960** to be ablated. As shown in **FIG. 9**, insulating material **932** may cover all of conductive element **922**. Insulating material **932** may be for example a microporous non-conductive component. Such a microporous non-conductive component may be manufactured from a material such as silicone, PTFE, Dacron fabric or solvent-precipitated polyurethane. Preferably, the pores

in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **924** of conductive element **922** in the manner indicated by the arrows.

FIG. 10 shows a schematic view of a cross-section of a fourth embodiment of a variable length electrode in accordance with the present invention. Conductive element **1022** may be, for example a conductive wire located in a non-porous tube **1040**. Irrigating fluid may be flowed through the lumen **1024** of tube **1040**. The non-porous tube **1040** may have a segment of insulating material **1032**. Preferably this segment **1032** may run the length of an entire conductive element **1022**. This segment **1032** may also run the length of an exposed section of a conductive element **1022** which has been exposed in a manner as described in the above embodiments. This segment **1032** may preferably face a surface of the tissue **1060** to be ablated. Insulating material segment **1032** may be for example a microporous non-conductive component. Such a microporous non-conductive component may be manufactured from a material such as silicone, PTFE, Dacron fabric or solvent-precipitated polyurethane. Preferably, the pores in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **1024** of nonporous tube **1040** in the manner indicated by the arrows.

FIG. 11 shows a schematic view of a cross-section of a fifth embodiment of a variable length electrode in accordance with the present invention. Conductive element **1122** may be, for example a conductive wire located in a non-porous tube **1140**. Irrigating fluid may be flowed through the lumen **1124** of tube **1140**. The non-porous tube **1140** may have a rigid segment **1132** of microporous non-conductive material. Preferably this segment **1132** may run the length of an entire conductive element **1122**. This segment **1132** may also run the length of an exposed section of a conductive element **1122** which has been exposed in a manner as described in the above embodiments. This segment **1132** may preferably face a surface of the tissue **1160** to be ablated. Rigid segment **1132** may be, for example, a microporous non-conductive component that is rigid. Such a microporous non-conductive component may be manufactured from a material such as rod

stock. Preferably, the pores in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **1124** of nonporous tube **1140** in the manner indicated by the arrows.

FIG. 12 shows a schematic view of a cross-section of a sixth embodiment of a variable length electrode in accordance with the present invention. Conductive element **1222** may be, for example a conductive wire located in a non-porous slotted tube **1233**. Such a slotted tube **1233** may be any suitable material that may provide additional structural integrity to conductive element **1222**. The slotted tube **1233** has an opening or slot **1234**. Preferably this opening **1234** may run the length of an entire conductive element **1222**. This opening **1234** may also run the length of an exposed section of a conductive element **1222** which has been exposed in a manner as described in the above embodiments. This opening **1234** may preferably face a surface of the tissue **1260** to be ablated. The lumen **1224** of tube **1233** may be filled with a material **1250** that exudes fluid such as, for example, a hydrogel. Irrigating fluid may be flowed through the hydrogel **1250** as described above. Alternatively, hydrogel **1250** may be saturated with irrigating fluid. When hydrogel **1250** contacts tissue **1260**, gel **1250** may exude sufficient irrigating fluid. Tube **1233** may be for example a microporous non-conductive component that is rigid. Such a microporous non-conductive component may be manufactured from a material such as rod stock. Preferably, the pores in the microporous non-conductive component may be large enough to allow the free flow of irrigating fluid but small enough so as not to become clogged with protein or other detritus from the tissue to be irrigated. Irrigating fluid may flow from the lumen **1224** of nonporous tube **1240** in the manner indicated by the arrows.

It is contemplated that the electrodes of the present invention may be used in a variety of ablation systems such as those available from Medtronic, Inc., Minneapolis, USA. It should be appreciated that the embodiments described above are to be considered in all respects only illustrative and not restrictive. The scope of the invention is indicated by the following claims rather than by the foregoing description. All changes that come within the meaning and range of equivalents are to be embraced within their scope.

WE CLAIM:

1. A device for ablating organic tissue, comprising:
a conductive element;
a fluid component in communication with the conductive element; and
an interface positioned adjacent the tissue to allow the fluid to pass through the interface and contact the tissue.

2. The device of claim 1, wherein the conductive element is a metallic coil with a lumen.

3. The device of claim 1, wherein the conductive element is a spring with a lumen.

4. The device of claim 1, wherein the conductive element has a conductive element diameter and the interface has an interface diameter, the conductive element diameter being greater than the interface diameter.

5. The device of claim 1, wherein the interface has a length, the length being variable.

6. The device of claim 1, wherein the interface is micro-porous.

7. The device of claim 1, wherein a portion of the interface may be removed to expose the conductive element.

8. The device of claim 7, wherein the interface is perforated.

9. The device of claim 7, wherein the interface may be rotatably opened.

10. The device of claim 1, wherein the interface comprises openings that may be slidably opened.

11. The device of claim 1, wherein the interface is non-conductive.

12. The device of claim 1, wherein the interface is from the group consisting of: silicones, PTFE, Dacron fabrics, solvent-precipitated polyurethane micro-porous polymeric coatings, stainless steel nitinol, machining rod stock, polyester fabrics, hydrogels and a gel.

13. The device of claim 1, wherein the interface lies between the conductive element and the surface of the tissue.

14. The device of claim 1, wherein the interface encircles the conductive element and the fluid component.

15. The device of claim 1, wherein the interface is conductive.

16. The device of claim 1, wherein the interface and the conductive element are the same.

17. The device of claim 1, wherein the conductive element is a wire, the wire located within the fluid component.

18. The device of claim 16, wherein the fluid component is a non-porous coating.

19. The device of claim 16, wherein the interface is a micro-porous section of the non-porous coating.

20. The device of claim 16, wherein the interface is a rigid structure.

21. The device of claim 16, wherein the interface is a fluid saturated gel.

22. The device of claim 20, wherein the interface and the fluid component are the same.

23. The device of claim 1 further comprising:
means for flowing the fluid component through the interface.

24. The device of claim 1 further comprising:
an infusion pump in communication with the fluid component for flowing the fluid component through the interface.

25. The device of claim 1 further comprising:
a maneuvering mechanism operably attached to the conductive element.

26. The device of claim 25, wherein the maneuvering mechanism is a hemostat-type tool.

27. The device of claim 25, wherein the maneuvering mechanism is a catheter.

28. A device for ablating organic tissue comprising:
a conductive element; and
a hemostat-type tool, wherein the conductive element is placed adjacent at least one jaw of the tool.

29. The device of claim 28, wherein the conductive element is a metallic coil with a lumen.

30. The device of claim 28, wherein the conductive element is a spring with a lumen.

31. A device for creating ablations of variable length, comprising:
a conductive element having a channel formed therein;
the channel operatively adapted to receive irrigating fluid; and
a removable non-conductive interface in communication with the conductive element.

32. The device of claim 31 further comprising:
a support element in communication with the conductive element.

33. The device of claim 31, wherein the support element is a slotted tube.

34. The device of claim 31, wherein the conductive element is a slotted tube.

35. The device of claim 31 further comprising:
a maneuvering mechanism operably attached to the conductive element.

36. The device of claim 31, wherein the maneuvering mechanism is a hemostat-type tool.

37. The device of claim 31, wherein the maneuvering mechanism is a catheter.

38. A device for creating ablations of variable length, comprising:
a non-porous tube operatively adapted to receive irrigating fluid therein;
a conductive element in communication with the tube; and
a removable non-conductive interface in communication with the conductive element.

39. The device of claim 38, wherein the non-conductive interface is a portion of the non-porous tube.

40. The device of claim 39, wherein the non-conductive interface is micro-porous.

41. The device of claim 38, wherein the non-conductive interface is rigid.

42. The device of claim 38 further comprising:
a maneuvering mechanism operably attached to the conductive element.

43. The device of claim 38, wherein the maneuvering mechanism is a hemostat-type tool.

44. The device of claim 38, wherein the maneuvering mechanism is a catheter.

45. A device for creating ablations of variable length, comprising:
a non-porous tube operatively adapted to receive a hydrogel;
a conductive element in communication with the tube; and
a removable non-conductive interface in communication with the conductive element.

46. The device of claim 45, wherein the tube is slotted.

47. The device of claim 45 further comprising:
a maneuvering mechanism operably attached to the conductive element.

48. The device of claim 47, wherein the maneuvering mechanism is a hemostat-type tool.

49. The device of claim 47, wherein the maneuvering mechanism is a catheter.

50. A method of ablating organic tissue, comprising:
providing a conductive element having a channel formed therein, the channel operatively adapted to receive irrigating fluid; and
a removable non-conductive interface in communication with the conductive element;

removing a portion of the interface to expose a portion of the conductive element; and

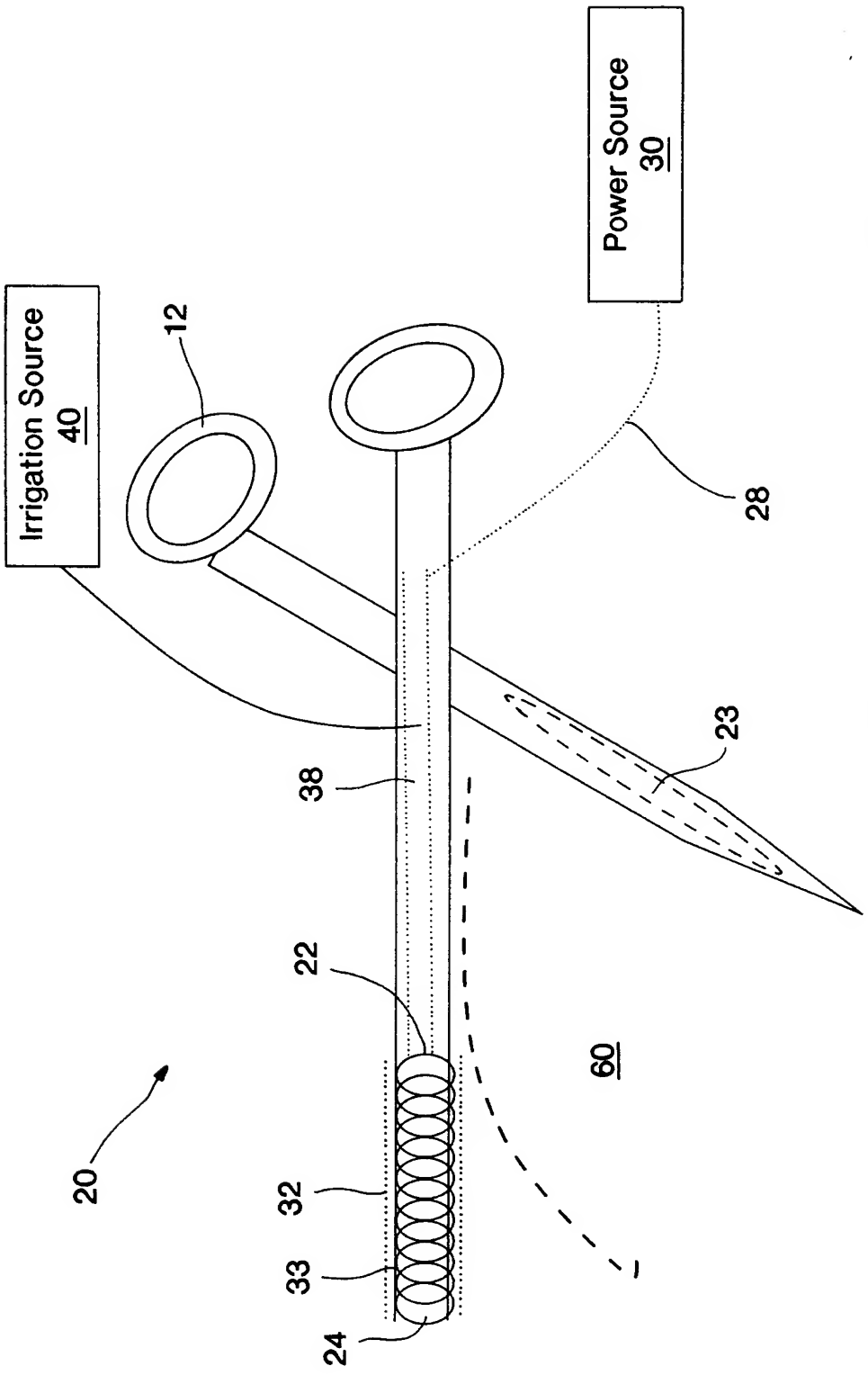
ablating the tissue with the exposed portion of the conductive element.

51. The method of claim 50, wherein the interface is perforated.

52. The method of claim 50, wherein the interface is disposable.

53. The method of claim 50, wherein the interface is reusable.

54. The method of claim 50, wherein the interface is a removable tip.


Power Source
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Irrigation Source
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23
38
22
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24

FIG. 1

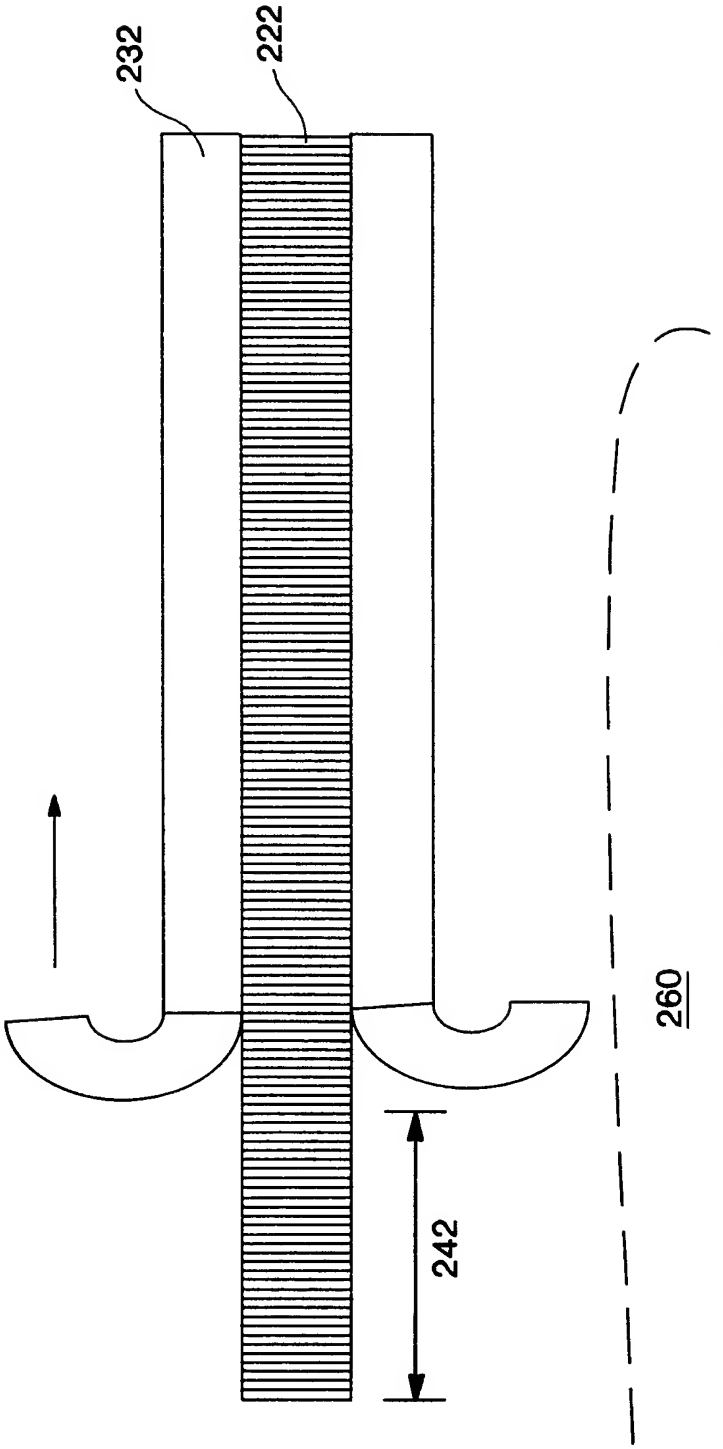


FIG. 2

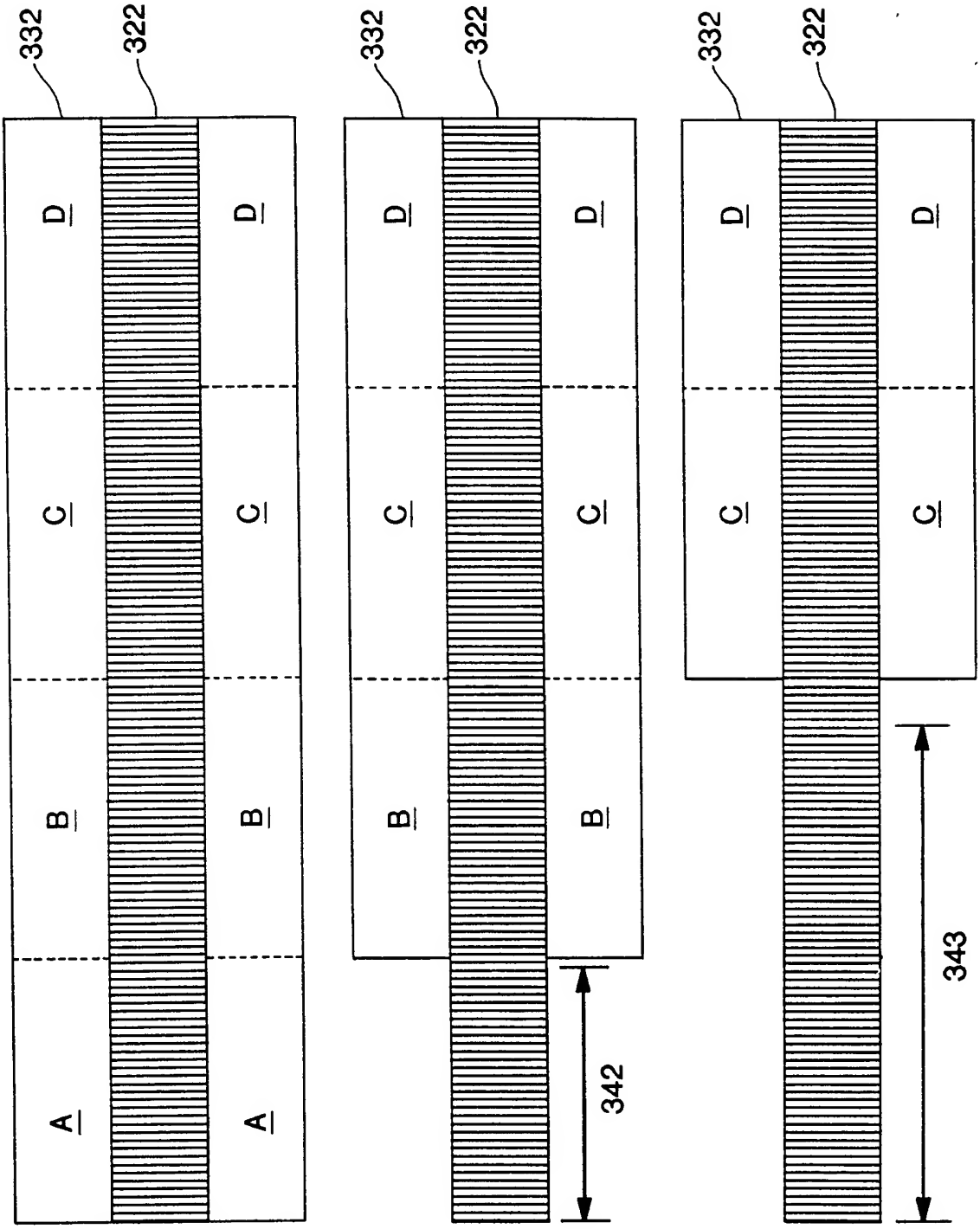


FIG. 3

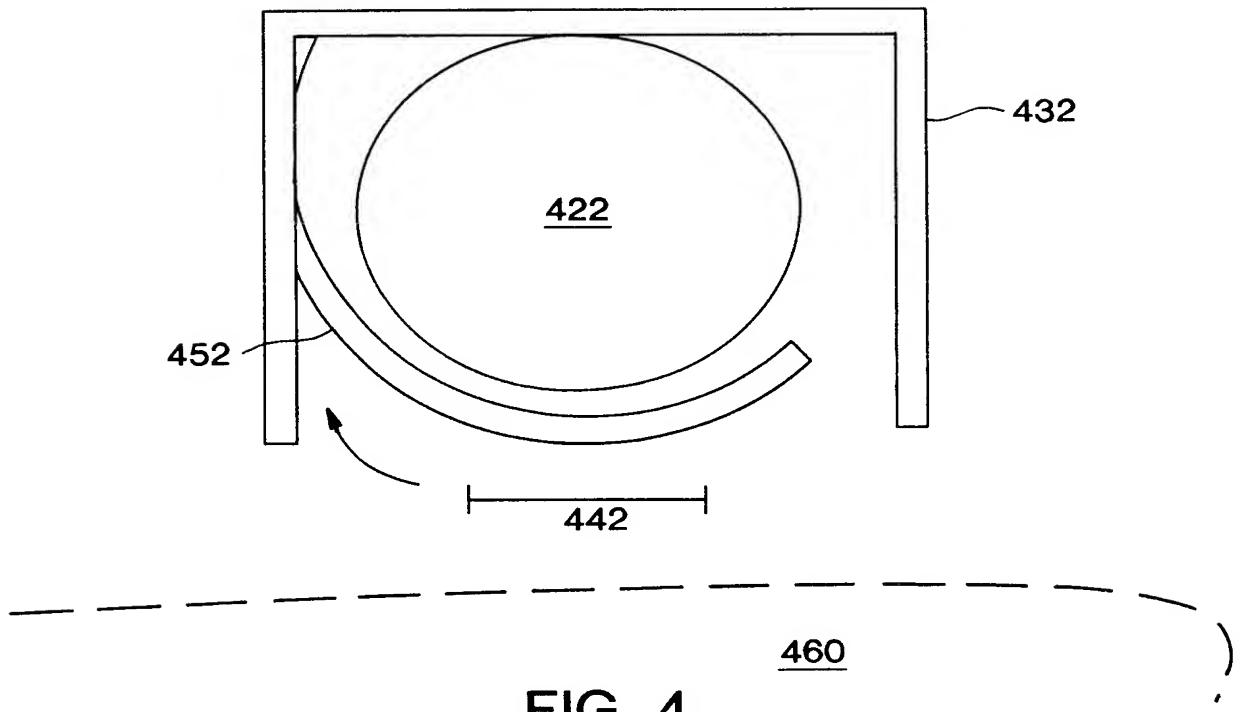
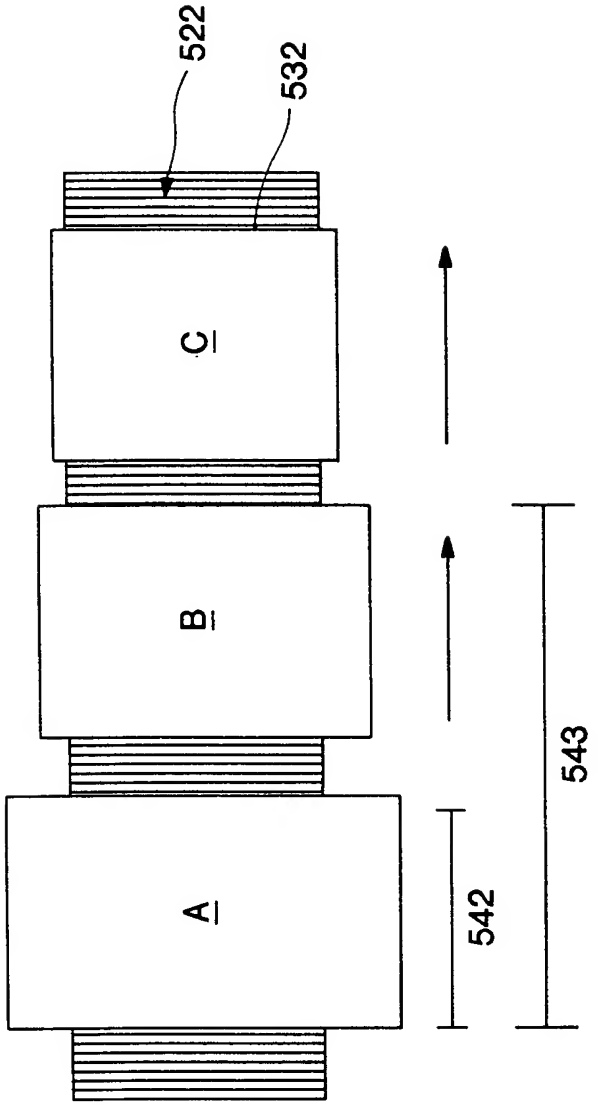


FIG. 4



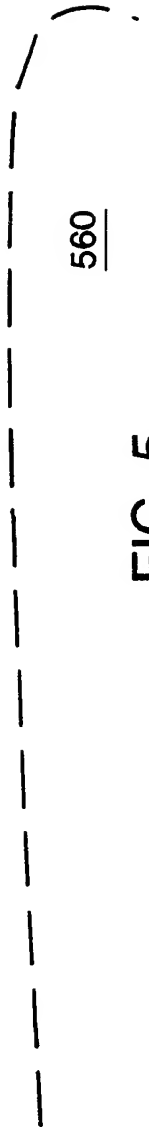


FIG. 5

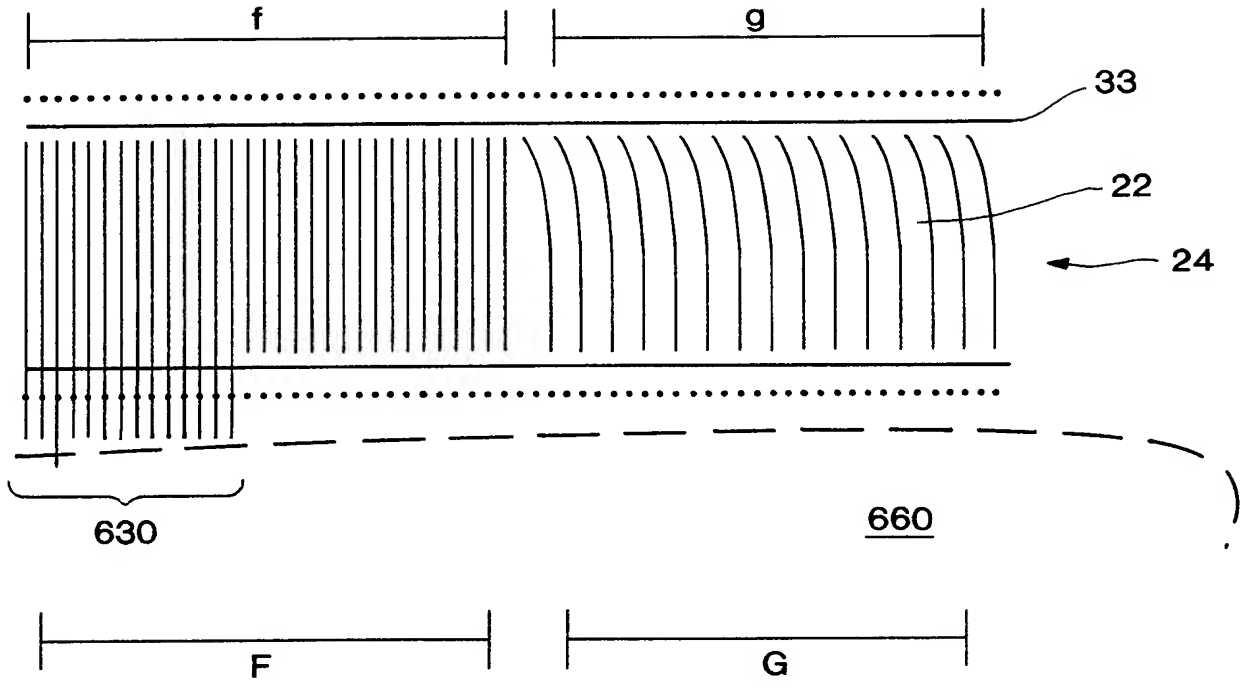


FIG. 6

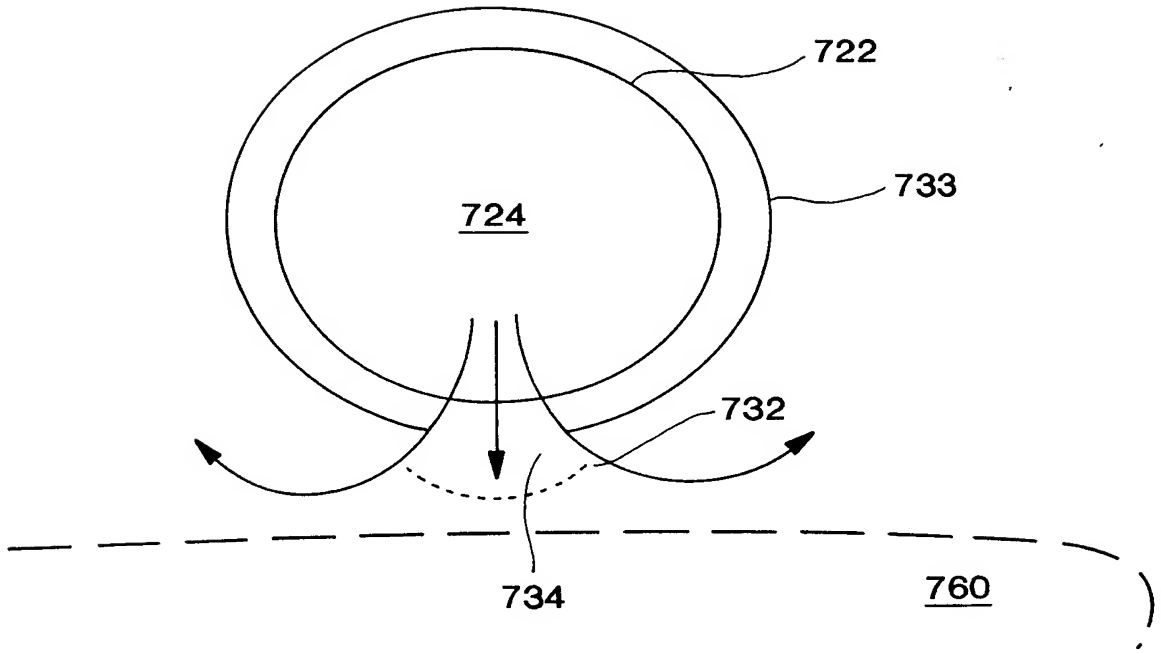


FIG. 7

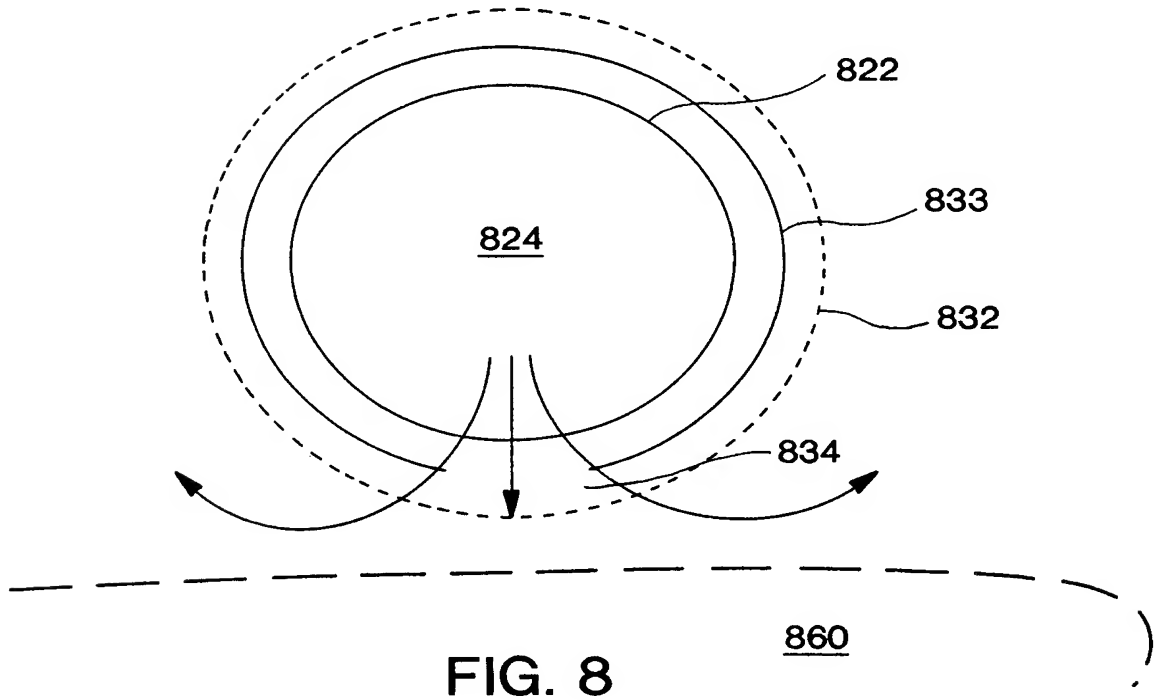


FIG. 8

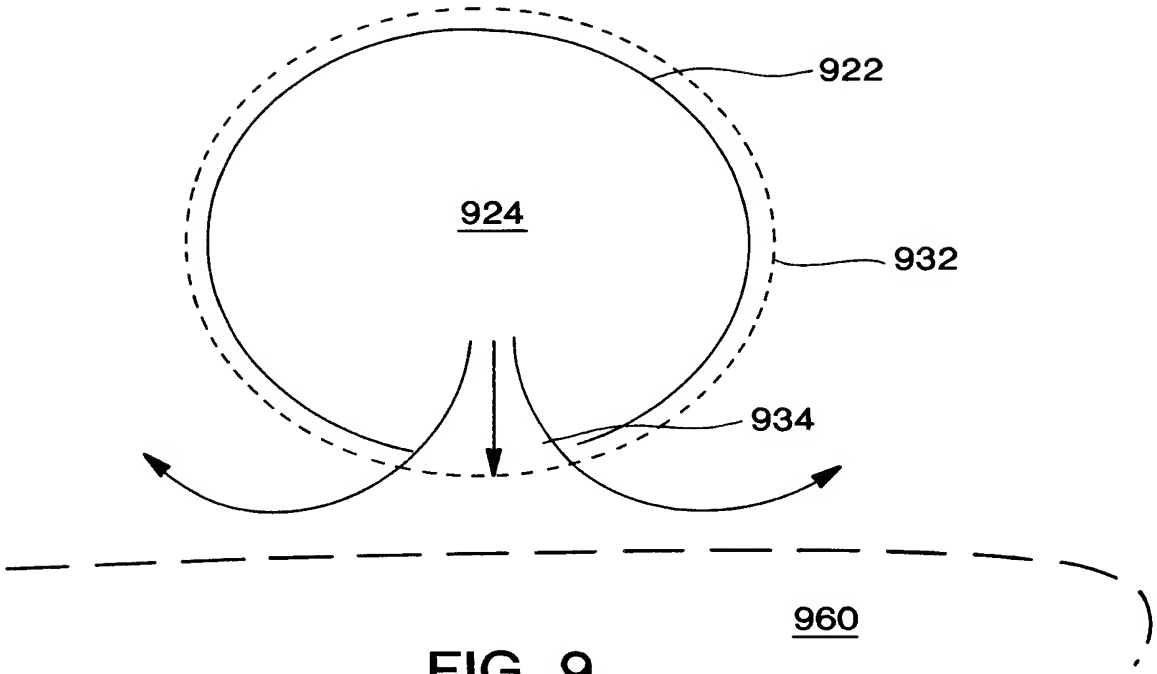


FIG. 9

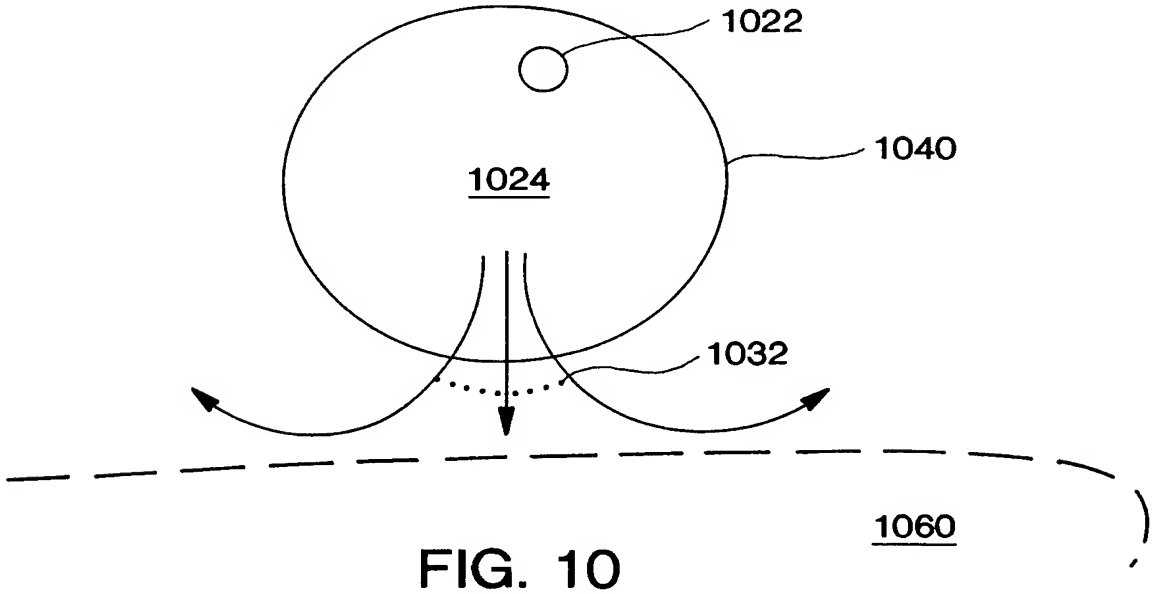


FIG. 10

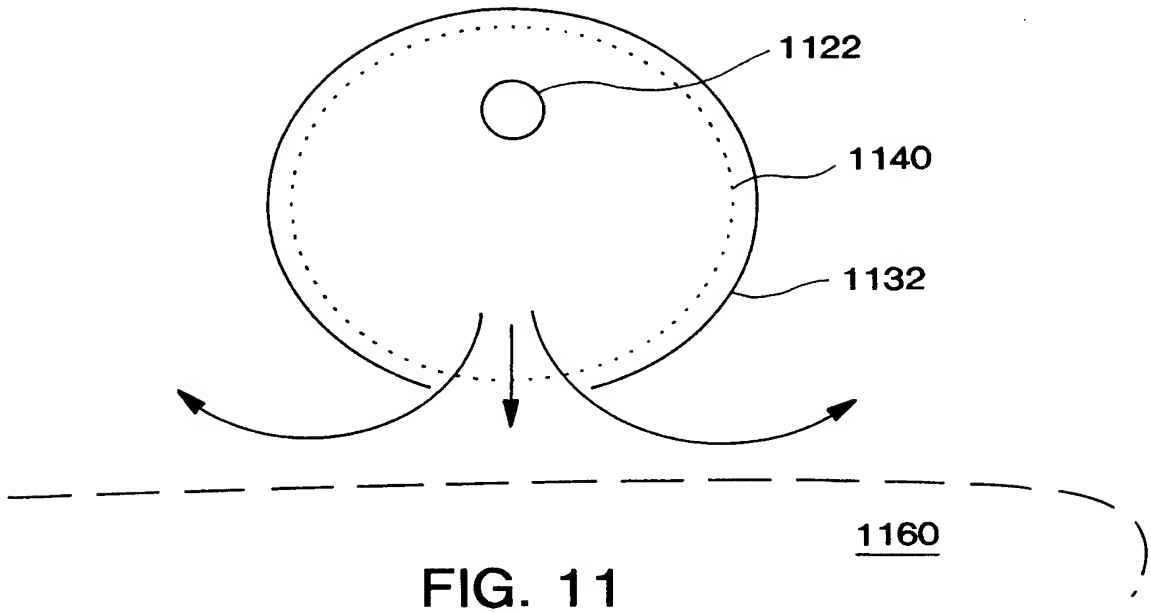


FIG. 11

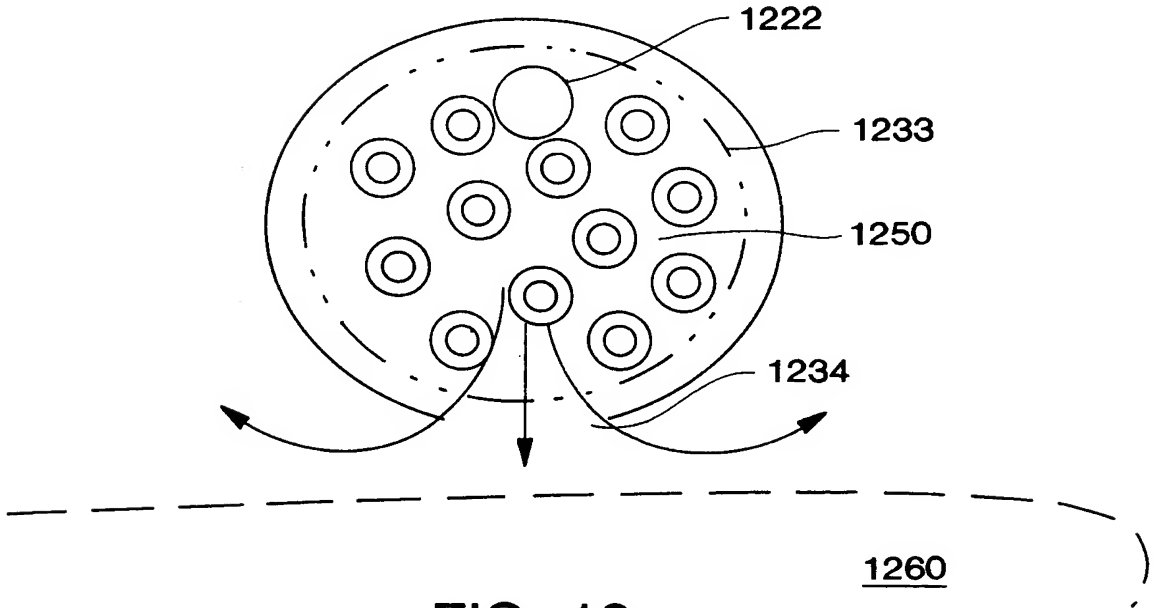


FIG. 12